NUTSHELL

In this lesson, students define "urban forest" and "ecosystem." They relate their school to an ecosystem and then create a web diagram to show the numerous connections in an urban forest. They extend that idea to the connections urban forests have to other ecosystems using the water cycle and carbon cycle as examples. Students consider how urban forests can help mitigate the impacts of climate change. The lesson concludes by having students write a few paragraphs to demonstrate their learning.

ENDURING UNDERSTANDINGS

- An urban forest is all the trees and other vegetation in and around a town, village, or city. Plants, people, and animals are part of the urban forest. (Subconcept 1)
- An urban forest is an ecosystem. An ecosystem is an area that contains living (e.g., trees, people, animals) and nonliving (e.g., soil, buildings, roads) things existing together and interacting. Humans play a dominant role in the ecosystem. (Subconcept 2)
- Urban forest ecosystems are part of matter cycling and energy webs. (Subconcept 4)
- Urban forests are a sink for carbon dioxide and a climate solution.

ESSENTIAL QUESTIONS

- What is an urban forest?
- What role do urban forest ecosystems play in other cycles and webs?
- What role can urban forest ecosystems play in mitigating or solving problems associated with climate change?

OBJECTIVES

Upon completion of this lesson, students will be able to:

- Define urban forest.
- Define ecosystem.
- Explain how humans are a major part of the urban forest ecosystem.
- Describe how urban forests are part of matter cycles and energy webs.
- Explain the important role of urban forests in climate mitigation or solutions.

SUBJECT AREAS

Language Arts, Science

LESSON/ACTIVITY TIME

Total Lesson Time: 130 minutes
Time Breakdown:

Introduction	5-10 minutes
Activity 1 **URBAN FOREST ECOSYSTEM WEB**	15 minutes
Activity 2 **URBAN FORESTS AND THE WATER CYCLE**	45 minutes (climate update)
Activity 3 **URBAN FORESTS AND THE CARBON CYCLE**	30 minutes (climate update)
Conclusion	30 minutes

MATERIALS:

FOR STUDENTS

- **Student Resource Sheet 1, 2, 3 or 4** (online or printed)
  https://docs.google.com/presentation/d/1mSf1CtR4SAbJZJclHvO434WXzvwUaCFQNzgARGgWx1w/edit?usp=sharing

- **Student Resource Sheet 5** (printed, same link as 1-4)
- Dictionary (online or print version)
- Maps of areas in their community (online or printed)
- Paper (for creating carbon cycle map)
- Markers/Colored pencils for creating carbon cycle map)

FOR THE TEACHER:

- **Educator Resources 1 - 6**
  https://docs.google.com/presentation/d/19zIXpFs65WsyvUUpfi8KHv7FDKqeMtqoYk1zlq9jRXQ/edit?usp=sharing

VOCABULARY

Carbon sinks: Something that stores more carbon than it emits into the environment (trees, ocean)
Carbon sources: Something that releases carbon into the environment (combustion of fossil fuels, decomposition of plants/animals, respiration)
Ecosystem: An area that contains organisms (e.g., plants, animals, bacteria) interacting with one another and their nonliving environment (e.g., climate, soil, topography).
Energy Web: A system where energy is transferred through a series of interconnected food chains.
Forest: An ecosystem that is characterized by a dominance of tree cover and contains a variety of other organisms (e.g., other plants, animals).
Matter Cycling: An ecosystem function in which elements are deposited, used by organisms, and stored or exported.
Projection: Estimate or forecast of a future situation or trend based on a study of present ones.
Rural Forest: A forest ecosystem found in the countryside outside of cities, towns, or neighborhoods.
Urban Forest: A forest ecosystem that includes all the trees and other vegetation in and around a town, village, or city. Plants, people, and animals are part of the urban forest.

BACKGROUND

We may not think of the trees along our streets, in parks, along rivers, and in yards as part of a forest, but they are. All the trees, other plants, and animals in a city, town, or village are part of an urban forest.

A forest is an ecosystem. An ecosystem is all the living and nonliving things in an area interacting with each other. In an urban forest, the increased influence of humans means that in addition to trees, other plants, animals, sun, and soil, there are people, buildings, concrete, asphalt, pets, and more. This makes the urban forest a unique type of forest ecosystem, but still one connected to other ecosystems.

It is important to note that rural forest ecosystems are not devoid of human influence. The difference between urban and rural forest ecosystems is in the degree of impact that people have on the forests.

When thinking about the interactions that occur in an urban forest, it may help to keep in mind that things that don't really seem "natural" to us are still part of this ecosystem. Just as rocks are part of other ecosystems, concrete and asphalt are part of urban forests. A squirrel in a rural forest relies on nuts and seeds to eat. In an urban forest, they may add bread that people throw for birds or even discarded french fries to their diet. Human influence is everywhere in an urban forest.

Trees face different challenges and benefits from their locations. In a rural forest, trees compete for nutrients, sunlight, space, and water. A well-maintained tree in an urban forest may be watered and fertilized so it doesn't need to compete for water and nutrients. However, an urban tree may also be

subjected to more air and water pollution. Competition for sunlight is fairly constant in both forest ecosystems.

FOOD CHAINS

Energy is defined as the ability to do work. It takes energy for living organisms to breathe, reproduce, and grow. In an ecosystem, energy passes from one organism to the next in a sequence. This is called a food chain. (Nutrients are also passed along in the food chain.) Producers form the beginning of the food chain by capturing the sun's energy through photosynthesis. Primary consumers eat producers, obtaining the chemical energy of the producers. Secondary consumers reap the energy stored in the primary consumers. Decomposers consume the remaining energy and break down organic molecules in the remains of all members of the food chain.

Food chains can be as short as two links. Chains longer than four or five links are not as common, but can occur. An example of a food chain would be aspen leaf – caterpillar – frog – snake – fox. Another simpler food chain could be aspen leaf – deer – wolf.

FOOD WEBS

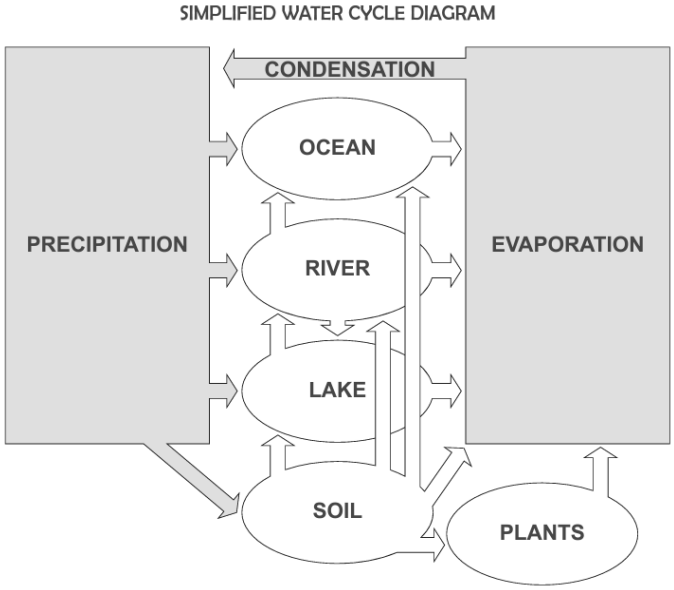
A food web is a set of interconnected food chains. Energy and materials circulate within an ecosystem through food webs. The chains become a web when there are mutual food sources. Consider the previous examples. Aspen leaf – caterpillar – frog – snake – fox and aspen leaf – deer – wolf are interconnected by the leaf. If we added dandelion – rabbit – fox, that adds more connections. When all of these are combined, we have a complex food web in an ecosystem.

CYCLING OF MATTER IN ECOSYSTEMS

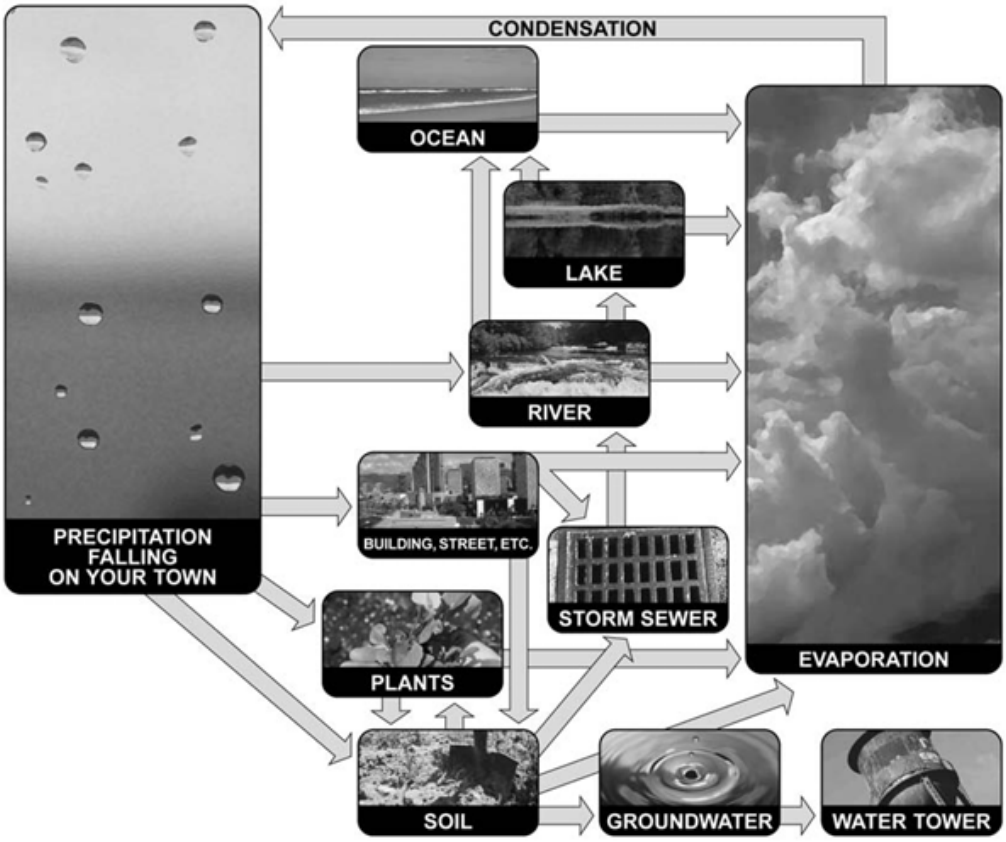
Matter cycles from biotic (living) communities to the abiotic (nonliving) environment and back again. There are a variety of cycles that materials flow in. Some of them are the carbon cycle, nitrogen cycle, phosphorus cycle, sulfur cycle, and water cycle. These are important to organisms because they involve materials used to make the chemical components of cells. Matter cycles through food webs and by other means. During this activity, we will take a closer look at both the water cycle and carbon cycle and the role urban forests play in both.

THE WATER CYCLE

The water cycle is the key to the other cycles. Water is often what carries the phosphorus, nitrogen, and sulfur from place to place. The water cycle is a series of movements of water above, on, and below the surface of the Earth. The water cycle consists of different stages including evaporation, condensation, transpiration, precipitation, and runoff. Water may be stored temporarily in the ground, oceans, lakes, rivers, icecaps, and glaciers. It evaporates from the Earth's surface, condenses in clouds, and falls back to the Earth as precipitation. Almost all the water on the Earth has passed through the water cycle countless times. The illustration shows some very simplified paths that water may follow.



The water cycle connects all parts of the Earth. Different parts impact the water cycle differently. Most water that falls on rural environments either flows into water bodies or is absorbed into the surface. Consider what might happen to water that falls on a city. Fewer land areas in an urban forest are covered by soil or water bodies that can readily absorb a raindrop compared to other ecosystems. Concrete sidewalks, asphalt streets, rooftops, and cars shed rain as it falls. Gutters and storm sewers carry water away from hard surface areas to prevent flooding. This water is eventually directed into lakes and rivers. Water that does soak into the soil will either end up in groundwater or will be taken up by plants and used in photosynthesis. The diagram below is a simplified example of how our communities interact with the water cycle.



It is important to remember that the water humans use also fits into this cycle. Municipalities get their water from a variety of sources. Sources can include large natural bodies of water, such as Lake Michigan, groundwater that is then stored in a water tower, and reservoirs filled with rainwater. That water is pumped into our homes and businesses. Some is put on lawns; it soaks into the soil and eventually back into groundwater. Some is used inside in our sinks, toilets, showers, dishwashers, etc. That inside water flows down the drain and into the sewage pipes. The sewage pipes carry water to a sewage treatment plant where waste is removed by a series of complex processes. That water, with the contaminants removed, is discharged into a nearby lake or river.

THE CARBON CYCLE

Carbon is part of the oceans, air, rocks, soil, and all living things. It is constantly cycling through the ecosystem. During photosynthesis carbon moves from the atmosphere to trees and plants when they take in carbon dioxide and turn it into sugars. Carbon may be stored in the roots and trunks of trees for years and is even stored in forest products like wood. The carbon remains in these forest products until it is burned (released to the atmosphere as carbon dioxide) or decomposes (moves into the ground). Carbon moves from trees and plants to animals through the food web when animals eat them and can also move from animal to animal in this way. Carbon also moves from living organisms into the atmosphere through respiration (breathing).

When plants and animals die, carbon moves into the ground through decomposition. Some decomposing plants and animals get buried and their carbon becomes fossil fuels over millions of years. When fossil fuels are burned, carbon quickly enters the atmosphere as carbon dioxide gas. Oceans take some carbon from the atmosphere. The ocean holds more carbon than any other part of Earth's biosphere. (Not shown in image.)

Generally, the amount of carbon in the atmosphere is decreased through marine sediments (carbonate) settling on the seafloor and the accumulation of plant biomass on land and in the ocean. The amount of carbon in the atmosphere is increased through the burning of fossil fuels and deforestation as well as through other processes.

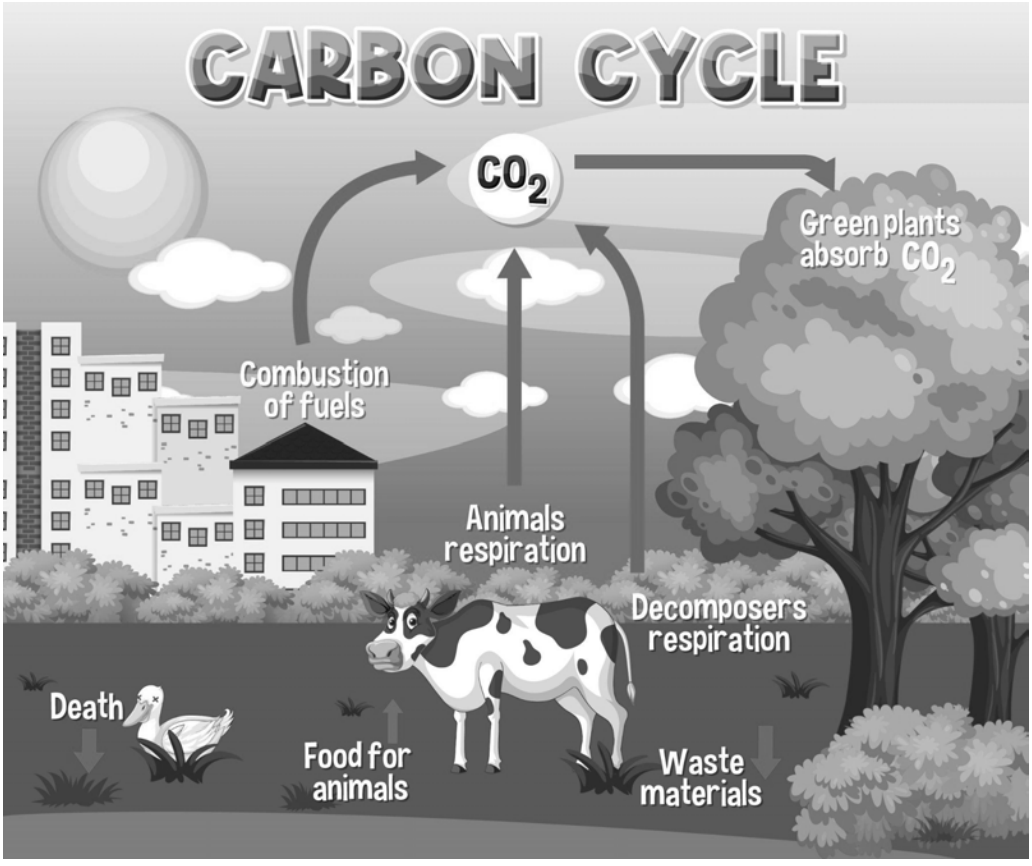


Image by brgfx on Freepik - https://www.freepik.com/free-vector/carbon-cycle-diagram-science-education_41852850.htm

PROCEDURE

INTRODUCTION

(Modified from Unit 7-8 Lesson 2 from theLEAF K-12 Forestry Lesson Guide.)

1. Ask students (by a show of hands) how many have heard the term **urban forest.** If some students have, ask them to explain what they think it means. List their definitions on the smartboard, whiteboard or chart paper, leaving space to also write the definitions of urban and forest.
2. Have several student volunteers look up the meanings of "urban" and "forest" in a dictionary (online or print format).
3. Add these definitions to the board/chart paper. There may be various definitions for each word.
4. Discuss what seem to be the key parts of each definition. *(Urban is in the context of city or town; forest includes trees and undergrowth in an area.)*
5. Put these key parts together to form a class definition of urban forest. *(An urban forest is all the trees and other vegetation in and around a town, village, or city.)* Discuss similarities and differences between this definition and what students thought the meaning was before looking it up.
6. Tell students they will be learning more about urban forests and what they are composed of.

ACTIVITY 1–URBAN FOREST ECOSYSTEM WEB

1. Ask students to name some of the parts of your school. Stress that you are not just talking about the school building, but the institution. *(Examples could include classrooms, halls, gymnasium, auditorium, lunch room, students, teachers, secretaries, principal, lunch room staff, bus drivers, books, desks, animals kept in classrooms, plants, etc.)* You may wish to write these on the board for reference. Begin a web-building exercise by linking one part to another with a verb. *(Teacher teaches students.)* Ask a student to continue using the word you left off with and linking it to another part. *(Students sit at desks.)* Continue until either all examples have been used or all students have had a chance to participate. Tell students that they just demonstrated how their school functions as a system.
2. Explain that, in a way, their school functions as an **ecosystem**. Ask students if they know what an ecosystem is (and if so, to define it). If nobody knows, ask for a volunteer to look up the word ecosystem. While the volunteer is looking, have the rest of the class suggest definitions. Have the volunteer read the definition out loud. *(An ecosystem is an area that contains organisms interacting with one another and their nonliving environment.)* Ask the class if they think their school qualifies. *(Yes, there are living things such as people, animals, and plants and nonliving things such as desks, books, and the building.)* Ask students to remember the definition of an urban forest they learned in the Introduction. Ask them if they think an urban forest qualifies as an ecosystem. *(Yes, there are living things such as people, squirrels, birds, trees, grass, flowers, and bacteria and nonliving things such as roads, sidewalks, buildings, soil, sun, and water that all interact.)*
3. Display **Educator Resource 1, Ecosystem Web** on the smartboard or write the information on a white board or chart paper. Explain that this graphic illustration of an urban forest ecosystem lists some of the parts *(humans, water, buildings, and trees)* of an urban forest. As a class, discuss why each of the examples is included. *(They are all living or nonliving things in an urban forest ecosystem.)* To get students started, draw lines between the parts and ask the class to suggest verbs that describe how they are connected. *(Humans drink water,humans live in buildings, trees shade buildings, buildings shade trees, humans plant trees, etc.)*

4. Leave the web where students can see it and ask them to get out a piece of paper. Have each student make their own web on the paper. They should use the information you have shared and also add their own ideas of parts and connections. The parts can be more specific examples of things already covered or more general things. *(Examples could be cars, parking lots, shrubs, grass, pigeons, squirrels, sidewalks, sun, etc.)*Tell students there will be more than one connection from many of the parts. Some parts may even connect to each other in more than one way. *(e.g., Humans build buildings, humans live in buildings.)*
5. Wrap up by adding some of the students' ideas to the web. Ask students what they think their ecosystem webs show. *(Answers will vary. Examples should include that humans have a major impact on the urban forest ecosystem, everything is connected somehow, there are many ways things are connected, etc.)*

ACTIVITY 2–URBAN FORESTS AND THE WATER CYCLE

1. Now that the class has created the urban forest ecosystem web, ask if they think it is independent of other ecosystems. *(No.)* Explain that all the connections they identified as part of an ecosystem can also be explained in different ways. *(Food web, energy web, cycling of matter.)*
2. Define and discuss **energy web**. *(A system where energy is transferred through a series of interconnected food chains. Energy is created by plants during photosynthesis. That energy is transferred from one organism to another as part of a food chain. When the food chains connect to each other this creates a web.)* Use energy web connections to describe how an urban forest ecosystem is connected to others. *(A berry growing on a tree in a city is eaten by a bird migrating from Canada to Central America. The energy the tree created through photosynthesis is transferred to the bird, which is connected to other ecosystems.)*
3. Define and discuss **matter cycling**. *(An ecosystem function in which elements are deposited, used by organisms, and stored or exported. Matter cycles through energy webs and other cycles. When a plant or animal is eaten for energy,the matter in that plant or animal is also transferred. Matter is exchanged in a variety of forms and ways.)*

   NOTE: If students need more discussion on matter cycling to be prepared for this lesson, see the LEAF Links section.

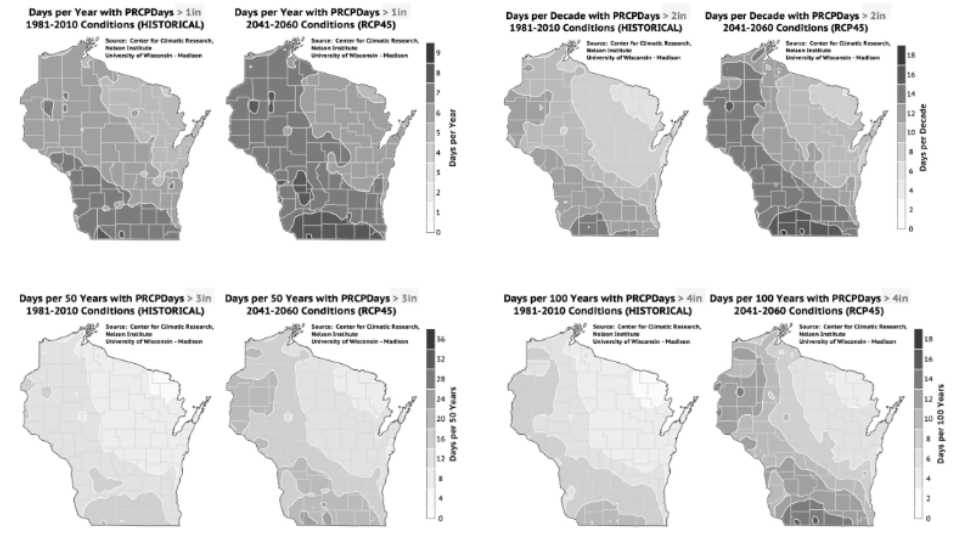
4. Ask students to share what they know about the water cycle. Fill in any gaps they are missing. *(Water falls from clouds as precipitation. It lands on oceans, lakes, rivers, or soil. It can flow from soil to groundwater, rivers, lakes, oceans or be taken up by plants. It will evaporate and return to the clouds from oceans, lakes, rivers, soil, or plants. Water often carries other things with it as it moves.)* A simplified illustration of this process is found on **Educator Resource 2, Simplified Water Cycle**. Tell students they are going to use the water cycle as an example of matter cycling.
5. Use **Educator Resource 3, Urban Water Cycle Example** to help lead a discussion about the water cycle in urban areas. Note that the diagram on Educator Resource 3, Urban Water Cycle Example will not necessarily be the same as your finished diagram. For instance, if you have a lake in your town, precipitation will fall on it directly instead of only being connected through a river.
    - Using a marker and chart paper, marker and dry erase board or chalk and chalkboard, write "precipitation falling on our town" in a box on the left side of the board.
    - Remind students that another main part of the water cycle is evaporation. Write that in a box on the right side, leaving room to add things between the boxes.
    - Ask students what the precipitation might fall on. *(Answers could include river, lake, soil, buildings, plants, people, etc. The list will depend on what is present in your community.)*

Write those answers in the space between "precipitation"and "evaporation" and circle them. Add arrows connecting the boxes and circles indicating which way water flows.
- Add more circles with things that precipitation doesn't land on but are still part of the water cycle. *(Groundwater, storm sewer, etc.)* Add arrows to include them in the cycle.

6. After the diagram is complete, stress to students the connections they just illustrated. Use an example if needed, such as the water that falls onto buildings could flow into storm sewers and then flow into a river. The river could carry that water to the ocean. Tell students that their community is connected to the ocean, even though it is thousands of miles away.
7. Make sure students discuss how they think TREES impact the movement of water in an urban water cycle. *(Canopy reduces impact of rainfall on some surfaces, Trees help absorb water and decrease runoff which slows rate of water flowing into storm sewers, river, lakes, etc. and can reduce flooding)*

CLIMATE UPDATE -

8. Explain to students that the average yearly rainfall in Wisconsin ranges from 28 inches up to 34 inches depending on where you are in the state. A light or moderate rain does not result in even 1 inch of total rainfall in a day. It takes heavy rain for several hours (2-5) to reach 1 inch of rainfall. Share **Educator Resource 4, Projected Rainfall 2041-2060** with students. Discuss what the word **projection** *(estimate or forecast of a future situation or trend based on a study of present ones)* means. Explain to students that these maps were created by the Nelson Institute Center for Climatic Research at the University of Wisconsin - Madison. The maps were made using global climate models to examine how Wisconsin's climate has been changing and project how it might change in the years to come. The maps assume emissions peak around the year 2040 and then decline. It is important to remind students that impacts will continue to increase for a while after reaching peak emissions before they start to decline.



Educator Resource 4

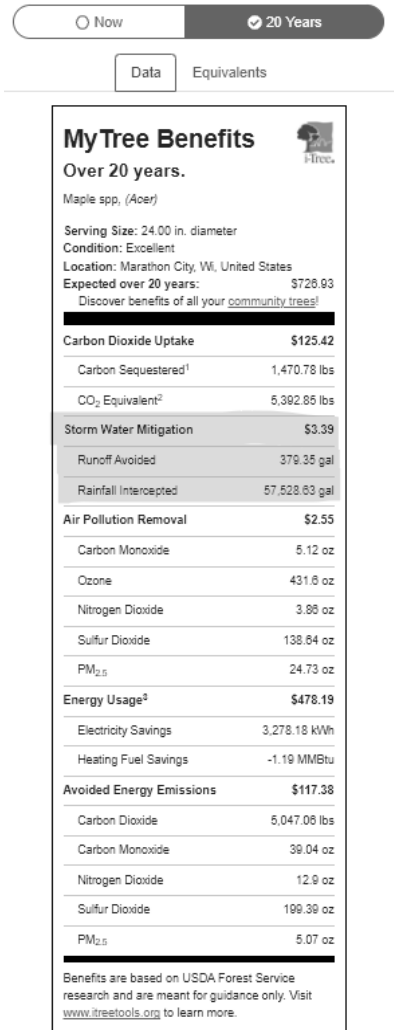
Maps created by Nelson Institutes Center for Climatic Research, University of Wisconsin - Madison
Maps published on the WICCI site: https://wicci.wisc.edu/wisconsin-climate-trends-and-projections/

9. Divide the students into groups. Give each group of students one copy of **Student Resource 1, 2, 3 or 4 Projected Rainfall >1, 2, 3 or 4 inches** and a copy of **Student Resource 5, Projected Rainfall Discussion Questions**. Ask students to use the maps to complete the questions. Tell them to be prepared to share what they learn with their classmates.

10. Have a whole-class discussion of the questions on **Student Resource 5, Projected Rainfall Discussion Questions.**
    - Question 1: *From 2041 through 2060 it is projected that Wisconsin will see an increase in days per year with rainfall that exceeds (1, 2, 3 or 4) inches. There are few, if any, areas in Wisconsin that will see no increase in days per year with rainfall that exceeds (1, 2, 3 or 4) inches. Some parts of Wisconsin will see an increase of 4-6 days per year with rainfall that exceeds (1, 2, 3 or 4) inches.*
    - Question 2: *More water in rivers and lakes (water moving to rivers and lakes faster), Flooding, washouts, erosion, carrying of contaminants into water, etc.*
    - Question 3: *Urban Forests/Trees can lessen the impact of rain falling on surfaces and minimize erosion; they also help hold soil/rock/etc in place. Urban Forests/Trees can absorb water from the ground and store it.*

EXTENSION TO ACTIVITY 2 - MyTree

11. Record the following information about a tree/trees at your school or in your neighborhood
    - Address
    - Tree Species
    - Tree Condition (Excellent, Good, Fair, Poor)
    - Trunk Size (diameter) measured at breast height (about 4.5 feet up from the ground) *You can calculate this by measuring the distance around the tree (circumference) and dividing it by pi (3.14). The program also allows you to enter the circumference of the tree if you want it to do the calculations for you.*
    - Sun Exposure (Full, Partial, Shade)
    - Distance to nearest building, age of nearest building and direction from the tree to the nearest building
12. Go to the MyTree itreetools website and click on "Get Started": https://mytree.itreetools.org/#/
13. Enter the information and click on *"Add more trees or get results."*
14. When you get to the *"Your list of trees"* page, click on the calculator icon for the tree you entered (or the calculator for all trees). Look at *"MyTree Benefits Data for Storm Water Mitigation"* (Runoff Avoided and Rainfall Intercepted). You can select the time period of *"Now"* which is equivalent to 1-year or *"20 Years"*. Also, click on equivalents to see how many bathtubs of water were absorbed by the tree.
15. Keep this tab open for use in Activity 3.

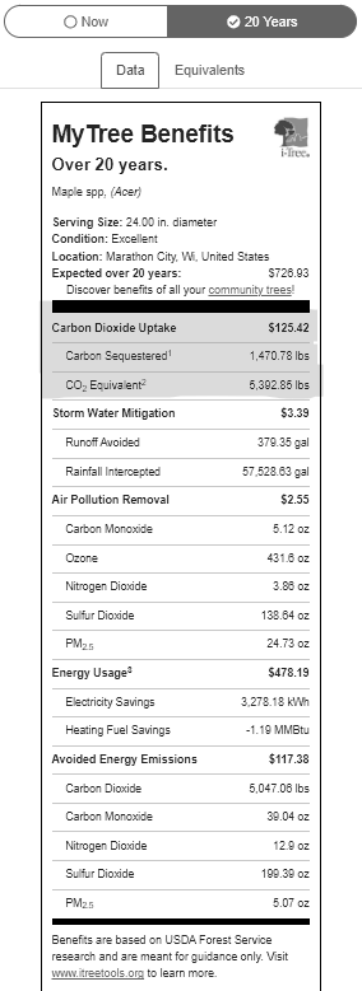


ACTIVITY 3–URBAN FORESTS AND THE CARBON CYCLE - CLIMATE UPDATE

1. Tell students you are going to continue to discuss matter cycling only this time you are going to look at the carbon cycle. Ask students what they know about the carbon cycle (students will likely have a lot less familiarity with the carbon cycle). Use **Educator Resource 5, Simplified Carbon Cycle** to help lead a discussion about the carbon cycle. Point out that trees are **carbon sinks** because they store more carbon dioxide than they release. Ask students to identify **carbon sources**. *(combustion/burning of fossil fuels - for electricity generation, heating and transportation; decomposing of plants/animals; respiration/breathing of organisms including humans, waste from organisms).*
2. Share that an important part of the carbon cycle is missing from the image - oceans. While Wisconsin is not located near any oceans, it is important to remember that oceans play a large role in the carbon cycle. Oceans hold about fifty times more carbon than the atmosphere. Some carbon dioxide absorbed by the oceans stays as a dissolved gas but most of it gets used by tiny marine plants (phytoplankton) through photosynthesis or by organisms that use carbon to make calcium carbonate for their shells/hard parts. Because oceans take more carbon from the atmosphere than they release, they are carbon sinks just like trees.
   What about lakes? Lakes bury large amounts of carbon in sediments - even more than oceans do because so many landscapes (and sediment from them) drain into lakes and that sediment settles there. One would think lakes would be great carbon sinks. However, even though lakes bury a lot of carbon, they are a net source of CO_2 due to the respiration (breathing) of bacteria, algae, zooplankton, fish, and other species.
3. Tell students that they will work in groups to create an Urban Carbon Cycle Map of their school community. Divide the class into groups of 2-4 students. Assign each group of students a particular area in the community that they will be responsible for mapping. Areas can be as small or large as you want depending on the amount of time you have to spend on this task. Consider printing maps of the areas for each student group or suggest they look at an online map. If students are looking at an online map, recommend they turn on both the satellite layer and traffic layer. Tell students they are going to create a new version of the map that shows carbon sources and carbon sinks in their community. At a minimum, students should include roads, waterways, CO_2 sources and CO_2 sinks on their maps. Instruct students to label the sources and sinks and try to show the scale of the sources and sinks on their maps. **Educator Resource 6, Carbon Cycle Map Example** can be shared with students as an example. Suggestions to give student groups: For communities with…
   - Tree-lined streets, students would pick a symbol to represent trees on their map and indicate they take in CO_2
   - School Forest, Parks with trees, would pick a symbol to represent forests on their map and indicate they take in even larger quantities of CO_2
   - Traffic (large urban settings) students would pick a symbol to represent cars on their map and draw several to indicate the cars emit CO_2
   - Farms (dairy, pig, chicken,etc) students would pick a symbol to represent animals on the outskirts of town and indicate they emit CO_2
   - Industries students would pick a symbol to represent factories and indicate they emit CO_2
   - Coal/natural gas burning power plant, students would pick a symbol to represent the power plant and indicate it emits CO_2

- Wind turbines/solar panels students would pick a symbol to represent renewable electricity sources and indicate they are carbon neutral (no addition or absorption of CO_2)
- Buildings, students would pick a symbol to represent the building and indicate it emits CO_2 (however, if the building has solar, it could be carbon neutral)

4. Once students have created their maps, ask them to come up with a brief summary of their area that includes:
   - Sources of CO_2
   - Sinks of CO_2
   - Classification of their area as:
     - Net source (produces more CO_2 than absorbs)
     - Net sink (absorbs more CO_2 than produces)
     - Neutral (produces about the same amount of CO_2 as it absorbs)
   - Explanation of their classification
   - What could be done to make this area more of a net sink?
5. Have groups share their maps and interpretation with their peers. Discuss the activity and look at the community as a whole after all student groups have presented. Remind students that CO_2 is always moving and it doesn't remain within the communities that emit it and that there are even more factors to consider when looking at a global scale (oceans as sinks, volcanic activity as emitter, larger forests, deforestation, etc).
6. Ask students why it is important to understand CO_2 and the carbon cycle. *(CO_2 emissions are a main cause of climate change which has adverse impacts for both natural and human communities. To come up with climate solutions, we have to understand the cause of the problem.)*
7. Ask students how they can play a role in reducing atmospheric CO_2 and being a part of a climate solution *(reduce electricity use, walk or bike more and drive less, plant trees, minimize organic waste - from food we throw away, etc)*



EXTENSION TO ACTIVITY 3 - MyTree

8. Return to your My Tree Benefits summary from Activity 2. Analyze and discuss the data related to Carbon Dioxide Uptake (located just above the Stormwater data). Look at the Data and Equivalents.

CONCLUSION - BEYOND THE URBAN FOREST

1. Share the definition of **rural forest** with students. *(A forest ecosystem found in the countryside outside of cities, towns, or neighborhoods.)* Discuss the difference between the rural forest and urban forest definitions. *(They are both ecosystems, but they differ in where they occur.)* Compare how humans impact urban forests to how they impact rural forests. *(Humans use forest products made from trees harvested in rural forests. They impact those forests from that use, even if they never go there. Urban forests are impacted by humans because humans live there. The immediate impact of humans on the area they live in is much greater.)*

2. Assign students to write a paper with three sections/paragraphs. The first paragraph should describe what an urban forest is and how it is different from what they know about rural forests (if students don't know much about rural forests yet, consider just having students describe what an urban forest is). The second paragraph should describe the role of urban forests in matter cycling - specifically how they connect to the water cycle and carbon cycle. The third paragraph should explain how urban forests can help mitigate impacts of climate change or be a climate solution.

ADDITIONAL RESOURCES

LEAF

The lessons listed below, for the LEAF Wisconsin K-12 Forestry Education Lesson Guide, contain possible enhancements, extensions, or replacements for Urban Forest Lesson Guide: 5-8 Lesson 1.

- **UNIT 5-6 LESSON 2: WHAT MAKES A FOREST?** Students explore parts of forest ecosystems and forest layers through an interactive game and discussion. Use 5-6 Lesson 2 Introduction and Activity 1 to introduce Urban Forest Lesson Guide: 5-8 Lesson 1 from a broad perspective. It could also be used after the lesson to broaden the focus from local to global. *https://www3.uwsp.edu/cnr-ap/leaf/SiteAssets/Pages/5-6-Wisconsin-Forestry-Lesson-Guide/5-6L2.pdf*
- **UNIT 5-6 LESSON 4: ECOSYSTEM EXTRAVAGANZA** Students are introduced to forest functions such as photosynthesis, energy flow, and the cycling of matter through reading and creating a diagram. The roles of producers, consumers, and decomposers in forests are also examined. Use 5-6 Lesson 4 to contribute to Urban Lesson Guide: 5-8 Lesson 1. Use the Introduction as an additional tool to help students understand connections. Activity 1, Activity 2, and Activity 3 can all be used to provide additional supporting exercises about energy webs and matter cycling. *https://www3.uwsp.edu/cnr-ap/leaf/SiteAssets/Pages/5-6-Wisconsin-Forestry-Lesson-Guide/5-6L4.pdf*

OTHER

Wisconsin Initiative on Climate Change Impacts - Forestry Working Group WICCI's Forestry Working Group is designed to share information across the forestry community about climate change impacts, adaptation, and mitigation.
https://wicci.wisc.edu/forestry-working-group/

Wisconsin Initiative on Climate Change Impacts - Trends and Projections WICCI climate scientists have "down-scaled" global climate models to project how Wisconsin's climate has been changing and how it might change in the years to come. View the maps to see historical trends and future projections for temperatures and precipitation.
https://wicci.wisc.edu/wisconsin-climate-trends-and-projections/

i-Tree i-Tree delivers current, peer-reviewed tree benefits estimation science from the USDA Forest Service to all types of users with free tools and support.
https://mytree.itreetools.org/#/

Articles on Urban Forests and Climate Change

A perspective on urban forests and climate change by Dea Larsen Converse, *Wisconsin Initiative on Climate Change Impacts*
https://wicci.wisc.edu/2021-assessment-report/land/a-perspective-on-urban-forests-and-climate-change/

City Trees and Soil Are Sucking More Carbon Out of the Atmosphere Than Previously Thought by Jessica Colarossi, 16 Feb 2022, *The Brink - Pioneering Research from Boston University*

https://www.bu.edu/articles/2022/city-trees-and-soil-are-sucking-more-carbon-out-of-the-atmosphere-than-previously-thought/#:~:text=Trees%20take%20in%20carbon%20dioxide,matter%2C%20which%20releases%20carbon%20dioxide.